

UTILIZATION OF SEED CORN WASTE FROM SEED CORN INDUSTRY INTO BIOETHANOL

Ni Ketut Sari, K. Y. Dharmawan, A. Gitawati

Jurusan Teknik Kimia Fakultas Teknologi Industri UPN” Veteran “Jatim

Jl. Raya Rungkut Madya Gunung Anyar, Surabaya 60294, E-mail : jur_tekimfti@upnjatim.ac.id.

E-mail: tk_upn_jatim@yahoo.com

Abstract

Alcohol or often referred to as ethanol (ethyl alcohol) in the industrialized world which is often used as a solvent, can be produced by fermentation using the yeast *Saccharomyces cereviceae*. The basic ingredients that can be fermented among other materials that contain saccharin, starch, and selullosa. Production of bioethanol to the current research done using basic materials derived from waste starch corn kernels from the corn seed breeding industry (PT.BISI INTERNATIONAL Tbk) is 63% starch content. Before the fermentation process, first performed by the process of hydrolysis using the enzyme-producing bacterial α -amylase is *Bacillus subtilis* to obtain a solution containing sugar (glucose). A solution containing the results of hydrolysis of 15,22% glucose is then fermented for a certain time interval by using yeast species *Saccharomyces Cereviceae*. From the experimental results obtained a conclusion that the maximum yield is obtained on 6 days hydrolysis bacillus 7,5% and a fermentation process using *Saccharomyces cereviceae* 7,5% which took place on 9 days with levels of bio-ethanol produced by 6,14%.

Key words: Waste Seed Corn, hydrolysis, fermentation, Bioethanol

1. INTRODUCTION

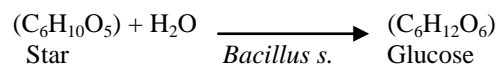
Growth in world consumption of ethanol has grown rapidly over the last few years. The growth of ethanol consumption during the 2001-2009 average of 17.8% per year. This growth is due to many countries in the world to encourage the use of ethanol as a fuel. It can be seen through the policies of countries in the world. In 2010, ethanol consumption in the world is estimated at 21.7 million gallons While in 2015 is expected to increase 45.24 million gallons. In Indonesia, the ethanol industry is less developed due to constrained raw materials in general use drops or molasses. In addition to drip factor is a necessary ingredient for other industries such as brewing and the manufacture of cooking spices, industrial or production capacity of sugar factories in Indonesia also declined.

Waste non-seed corn seeds are currently available 20 tons of untapped and the average waste production of seed corn reached 2-4 tons / month. With a potential source of raw materials to make sure bioethanol will be available in large enough quantities.

2. STRUCTURE OF WRITING

The process of hydrolysis

Hydrolysis, the process of breaking compounds into simpler compounds with the aid of water molecules (Othmer, 1967).



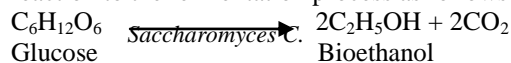
The process of hydrolysis is influenced by several factors, among others:

- the content of starch in raw materials
- temperature hydrolysis
- pH
- time

Fermentation process

Fermentation is a process of chemical change in an organic substrate through the activity of enzymes produced by microbes.

Principle the formation of bio-ethanol reaction to the fermentation process as follows



Factors that affect the fermentation process are as follows

- pH
- Time
- Temperature
- Sugar concentration

3. METHODOLOGY

This study uses the raw material waste starch content of corn kernels with $\pm 63\%$. The catalyst used was *Bacillus subtilis*, *Saccharomyces cereviceae*. First done soaking, washing, drying and grinding to get the raw materials of corn flour.

Materials - materials that are needed

Materials - materials that are needed in this research is

1. Waste corn kernels.
2. *Saccharomyces Cereviceae*.
3. *Bacillus subtilis*
4. HCl
5. Aquadest

Tools used

hydrolysis and fermentation tools

hydrolysis tools picture



Note:

1. Stirring spoon
2. Beaker glass for hydrolysis.

Fermentation tools picture



Caption :
 1. Ferment
 ation
 bottle
 2 Shaker

Variables are used:

1. Hydrolysis process

• The condition specified

- a. pH = 4.5 (with the addition of HCl or NaOH)
- b. Comparison of corn with water = 1:3 (333.3 g corn 1 liter of H₂O); 1:5 (200 g corn 1 liter of H₂O)
- c. The volume of waste corn kernels = 50 ml
- d. Temperature = 25 °C
- e. *Bacillus subtilis* = 5, 7.5, 10 (% v / v) of the filtrate

• Condition of runs

Time of hydrolysis = 2; 4; 6 (days)

2. Fermentation process

• The condition specified

- a. The volume of waste corn kernels = 50 ml
- b. pH = 4.5
- c. Temperature = 25 °C
- d. *Saccharomyces* = 5; 7.5; 10 (% v / v) of the filtrate

• Condition of runs

Time of Fermentation = 3; 6; 9; 12; 15 (days)

Bioethanol Making Procedures

Waste corn kernels soaked up the red color present in waste seed corn is gone, after washing and drying. Then finely ground into a homogeneous size (corn flour). Waste corn seed that has been the corn flour mixed with a ratio of 1:3 H₂O (333.3 g of corn and 1 liter of H₂O) and 1:5 (200 g of corn and 1 liter of H₂O). Hydrolysis carried out with a set of pH 4.5 and 50 ml of waste. Then embed *Bacillus subtilis* starter with a concentration of 5; 7.5; 10 (% v / v), with a time of hydrolysis for 2, 4, 6 days.

The next stage is to embed the *Saccharomyces cereviceae* starter with a concentration of 5; 7.5; 10 (% v / v), fermentation conducted for 3, 6, 9, 12, 15 days. Filtered, the filtrate was taken and analyzed bioethanolnya level.

4. RESULTS AND DISCUSSION

1. Analysis of Raw Materials

Analyses were performed using a spectrophotometer at the laboratory instrument. In the analysis of waste corn starch

derived starch content of 63% and levels of pesticide to 1:3 is 5.52 mg/l, to 1:5 is 1.244 mg/l, while in general the level of normal starch in corn kernels is about 80 - 85%.

2. The results of hydrolysis

Table 1. The results of the analysis of glucose and starch remaining in the process of hydrolysis

Bahan Baku	Waktu Hidrolisa (hari)	Kadar Glukosa (%)			Kadar Pati (%)		
		5%	7,5 %	10%	5%	7,5 %	10%
1:3	0	1.21	1.21	1.21	17.36	17.36	17.36
	2	2.11	5.31	3.09	16.98	15.56	16.05
	4	5.34	8.35	5.97	15.31	12.91	14.53
	6	6.33	9.52	7.46	13.76	10.01	12.31
1:5	0	0.81	0.81	0.81	11.19	11.19	11.19
	2	3.32	6.32	5.17	10.77	9.15	10.12
	4	5.09	10.65	7.45	10.01	8.76	9.32
	6	7.43	15.22	11.12	9.31	7.13	8.11

Based on Figure 1, shows that longer hydrolysis produced glucose levels increase, because the longer the hydrolysis, more starch is hydrolyzed to form glucose. At the same hydrolysis, bacillus addition of glucose 7.5% yield the greatest. In addition to its smaller bacillus (5%), hydrolyzed starch into smaller glucose that is because large amounts of starch by bacillus low. At high concentrations of bacillus with a certain amount of starch resulted in bacillus die for lack of flour. The optimum conditions obtained at the level of bacillus subtilis at 7.5% with 9.52% glucose.

A. Comparison of 1:3

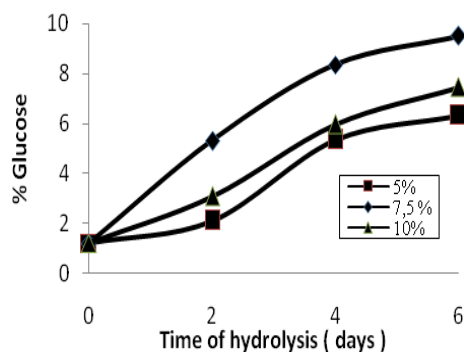


Figure 1. Effect time of hydrolysis on the % glucose

Based on Figure 1, shows that longer hydrolysis produced glucose levels increase, because the longer the hydrolysis, more starch is hydrolyzed

to form glucose. At the same hydrolysis, bacillus addition of glucose 7.5% yield the greatest. In addition to its smaller bacillus (5%), hydrolyzed starch into smaller glucose that is because large amounts of starch by bacillus low. At high concentrations of bacillus with a certain amount of starch resulted in bacillus die for lack of flour. The optimum conditions obtained at the level of bacillus subtilis at 7.5% with 9.52% glucose.

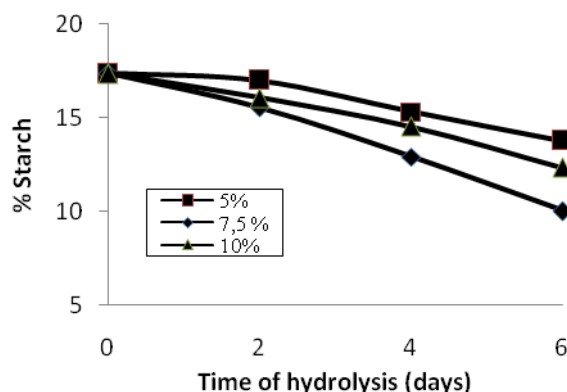


Figure 2. Effect time of hydrolysis on the % residual

starch

Based on Figure 2, shows that the longer time of hydrolysis of starch content the smaller the residual, because it takes longer hydrolysis, more starch is hydrolyzed to form glucose. At the same time the hydrolysis, the addition of 7.5% is bacillus remaining starch at its lowest at 10.01%.

B. Comparison of 1:5

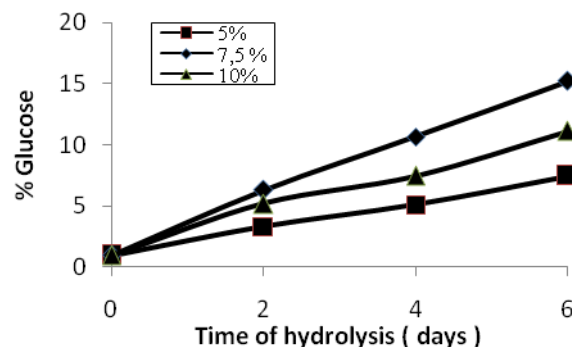


Figure 3. Effect time of hydrolysis on the % glucose

Based on Figure 3, shows that longer hydrolysis produced glucose levels increase, because the longer the hydrolysis, more starch is hydrolyzed to form glucose. At the same hydrolysis, bacillus addition of glucose 7.5% yield the greatest. In addition to its smaller bacillus (5%), hydrolyzed starch into smaller glucose that is because large amounts of starch by bacillus low. At high concentrations of bacillus with a certain amount of starch resulted in bacillus die for lack of flour. The optimum conditions obtained at the level of bacillus subtilis glucose level of 7.5% to 15.22%.

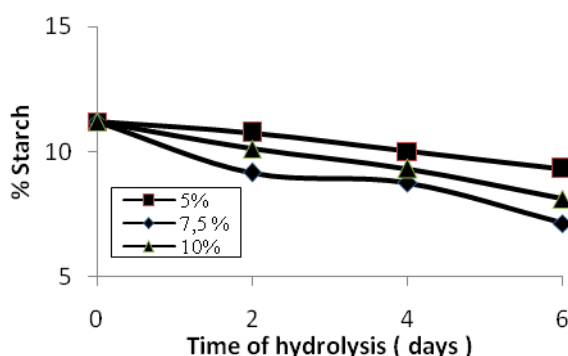


Figure 4. Effect time of hydrolysis on the % residual starch

Based on figure 4, it appears that the longer time of hydrolysis of starch content the smaller the residual, because it takes longer hydrolysis, more starch is hydrolyzed to form glucose. At the same time the hydrolysis, the addition of 7.5% is bacillus remaining starch is at its lowest in 7.13%.

3. Fermentation Results

Table 2. Analysis results on the levels of bio-ethanol fermentation process

Bahan Baku	Waktu Hidrolisa (hari)	Waktu Fermentasi (hari)	Kadar Bioethanol (%)			Yield (%)		
			5%	7.5%	10%	5%	7.5%	10%
1:5	2	3	0.27	0.76	0.52	1.22	3.49	2.43
		6	1.76	2.88	2.16	7.94	13.23	10.11
		9	3.23	5.85	4.67	14.57	26.88	21.86
		12	3.24	5.86	4.68	14.61	26.93	21.90
		15	3.24	5.86	4.68	14.61	26.93	21.90
	4	3	0.41	0.80	0.63	1.85	3.68	2.95
		6	2.19	3.02	2.72	9.88	13.88	12.73
		9	4.01	5.99	5.06	18.09	27.53	23.68
		12	4.01	5.99	5.17	18.09	27.53	24.20
		15	4.12	6.00	5.17	18.58	27.57	24.20
	6	3	0.44	0.85	0.75	1.98	3.91	3.51
		6	2.22	3.11	2.76	10.01	14.29	12.92
		9	4.45	6.14	5.24	20.07	28.22	24.53
		12	4.51	6.15	5.34	20.34	28.26	24.99
		15	4.62	6.16	5.35	20.84	28.31	25.04

B. Comparison of 1:5

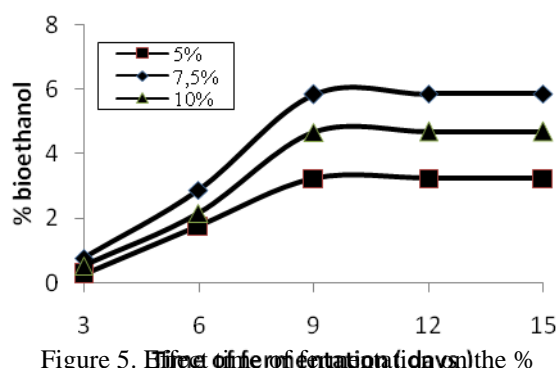


Figure 5. Effect of time of fermentation on the % bioethanol, 2 hours hydrolysis

Based on Figure 5, shows that the longer the fermentation rate increases obtained bioethanol and bioethanol at some point level to be constant, this is because the life of microorganisms Saccarhomyces logarithmic form. At the same fermentation, Saccarhomyces addition of 7.5% produces the largest bio-ethanol is 5.85% to 26.88% results. Because Saccarhomyces low, so the disintegration of glucose into bioethanol small because a large amount of glucose by Bacillus low. At high concentrations Saccarhomyces with a certain amount of glucose that resulted Saccarhomyces die from lack of glucose.

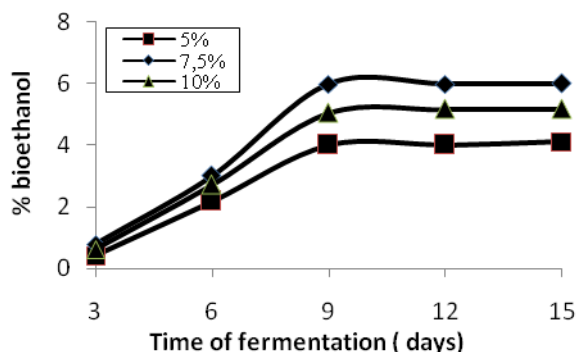


Figure 6. Effect of time fermentation on the % bioethanol, 4 day hydrolysis

Based on Figure 6, shows that the longer the fermentation rate increases obtained bioethanol and bioethanol at some point level to be constant, this is because the life of microorganisms *Saccarhomyces* logarithmic form. At the same fermentation, *Saccarhomyces* Addition of 7.5% produces the largest bio-ethanol is 5.99% to 27.53% results. Because *Saccarhomyces* low, so the disintegration of glucose into bioethanol small because a large amount of glucose by *Bacillus* low. At high concentrations *Saccarhomyces* with a certain amount of glucose that resulted *Saccarhomyces* die from lack of glucose.

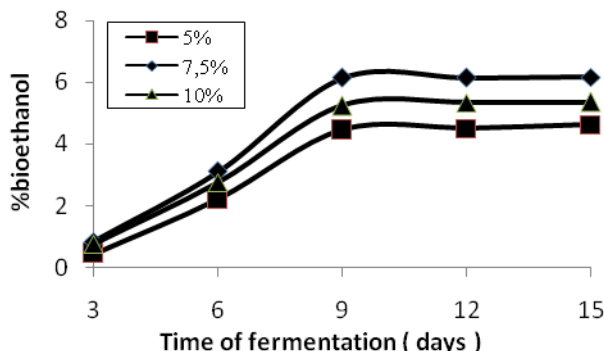


Figure 7. Effect time of fermentation on the % bioethanol, 6 hours hydrolysis

Based on the number 7, shows that the longer the fermentation rate increases obtained bioethanol and bioethanol at some point level to be constant, this is because microorganisms *Saccarhomyces* logarithmic forms of life. At the same fermentation, *Saccarhomyces* Addition of 7.5% produces the largest bio-ethanol is 6.14% to

28.22%. Because *Saccarhomyces* low, so the disintegration of glucose into bioethanol small because a large amount of glucose by *Bacillus* low. At high concentrations *Saccarhomyces* with a certain amount of glucose that resulted *Saccarhomyces* die from lack of glucose.

5. CONCLUSION

Based on these results we can conclude several things:

1. Waste containing 63% corn starch and glucose 4.85%.
2. The process of hydrolysis of starch into glucose is best at a ratio of 1:5 (weight per solvent) with a hydrolysis time of 6 days and 7.5% glucose bacilli obtained 15.22%.
3. In the process of fermentation with a ratio of 1:5 (weight per solvent) with a time of 9 days of fermentation and *Saccarhomyces* 7.5% bio-ethanol obtained the best level of 6:14%.
4. The results obtained in the fermentation process at a ratio of 1:5 (weight per solvent) with a fermentation time of 9 days and 7.5% *Saccarhomyces* obtained 28.22% rate of return of the best.

Suggestion

We recommend that the process of hydrolysis of starch into glucose using the bacillus is not so good results that suggest the need to use hydrochloric acid hydrolysis.

6. REFERENCES

- [1] Anonymous, http://wikipedia_jagung.html.
- [2] Anonymous, <http://id.wikipedia.org/wiki/Amilum>.
- [3] Anonymous, http://en.wikipedia.org/wiki/Ethanol_fuel.
- [4] Anonymous, <http://en.wikipedia.org/wiki/Bacillus>.
- [5] Budiyo, Krisno Agus. H. DR. Kes. 2002. Basic Microbiology. Muhammadiyah University. Malang.
- [6] Groggins, P. H. 1958. Unit Process in Organic Synthetic. Fifth edition. McGraw Hill: Kogakasha

- [7] Hudiko, Teo. 2009. Fuel Grade Ethanol Factory Of Elephant Grass. UPN "Veteran" East Java, Surabaya.
- [8] Kirk, R. E., Othmer, D. F. 1952. Encyclopedia of Chemical Thecnology. 2nd ed. Volume 10. Peinhold Van Nostrand Company: New York.
- [9] PT.Bisi International Tbk, 2010
- [10] Rahman, Ansori. 1989. Introduction to Fermentation Technology. Ministry of Education and Culture Directorate General of Higher Education Inter-University Centre for Food and Nutrition IPB: Bogor.
- [11] Sa'id, E., Gumbira. 1987. Application of Fermentation Technology. PT. Melton Son: New York.
- [12] Sa'id, E., Gumbira. 1989. Fermenters. IPB: Bogor.
- [13] Sari, Ketut. 2010. Purification Purification of Bioethanol From Grass Elephant With Batch Distillation. Journal of Chemical Indonesia (Acepted). Faculty of Chemical Engineering ITB: New York.
- [14] Tjokroadikoesoemo, P., Soebijanto. 1986. HFS and Other Industrial Cassava. PT. Scholastic Press: New York.
- [15] Winarno, F.G., 1994. Food Chemistry and Nutrition. PT. Scholastic Press: New York.
- [16] Yuliana, Devi. 2005. Liquid Waste Utilization Tapioca Starch For Ethanol. UPN "Veteran" East Java, Surabaya.